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ABSTRACT

A series of studies will collect empirical data on consonant development in children, in relation to three major issues of phonological theory: basic units, universal hierarchy, and recognition vs. production. Topics of investigation will be: English initial fricatives, English glide consonants singly and in clusters, and Spanish intervocalic consonants. Subjects of the studies will range from 1 year to 4 years of age. Spanish-speaking children will be from theRedwood City Mexican-American community. Methods of investigation will include the Shvachkin-Garnica discrimination technique, observation of spontaneous production, word imitation, and the use of published diary studies. On the basis of Jakobson's theory of child phonology development and six additional principles, a number of specific problems and explicit hypotheses will be investigated. (Author/DB)

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by

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ASPECTS OF THE ACQUISITION OF ENGLISH AND SPANISH PHONOLOGY

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New Proposal

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Abstract

A series of studies will collect empirical data on consonant development in children, in relation to three major issues of phonological theory: basic units, universal hierarchy, and recognition vs. production. Topics of investigation will be: English initial fricatives (f v θ ð s z ʃ ʒ), English glide consonants (r l w j) singly and in clusters, and Spanish intervocalic consonants. Subjects of the studies will range from 1 year to 4 years of age. Spanish-speaking children will be from the Redwood City Mexican-American community. Methods of investigation will include the Shvachkin-Garnica discrimination technique, observation of spontaneous production, word imitation, and the use of published diary studies. On the basis of Jakobson's theory of child phonology development and six additional principles, a number of specific problems and explicit hypotheses will be investigated.

Descriptors

child development
English language
fricatives
glide consonants (= semivowels and liquids)
liquids (consonants)
Mexican-Americans (= Chicanos)
phonology
semivowels
Spanish language
speech discrimination
speech production

Aspects of the Acquisition of English and Spanish Phonology

Background

At the present time there is great ferment in the field of phonological theory. In generative phonology much attention is being paid to such questions as the correct inventory of universal phonetic features, the admissible forms of phonological rules, and notions of naturalness and marking (Chomsky and Halle 1968, Stanley 1967, Sampson 1970). There is renewed interest in the process of sound change, which is being attacked from several directions (Labov 1965, Kiparsky 1968). The concern for arriving at phonological universals is also found in theoretical models differing considerably from current generative phonology (Ferguson 1966, Greenberg 1966, Stampe 1969). In contrast to the situation in phonological theory before the 1960's, there is general agreement now that the study of child language development is directly relevant to the basic issues. The first linguist to call attention to this was Roman Jakobson in his 1941 monograph Kindersprache, now available in English translation (Jakobson 1968).

Up to the present time, however, there has been very little research on child phonology carried out by linguists or linguistically oriented workers. The Stanford project "Aspects of the Acquisition of English Phonology" (NSF GS-2329) is one of the few projects in this field. It has used a multiple approach, studying both discrimination and production and making use of naturalistic observations, experiments, and published diary studies. The present proposal represents a continuation of that work, focusing the study on somewhat different areas of the phonology and extending it also to another language.

Major Issues

(a) Basic Units

One major issue in phonological theory is what constitutes the basic units of phonological systems. Among the possible units are linear segments (phonemes), simultaneous components (distinctive features), syllables, oppositions between sound types, and phonological rules relating lexical identifiers to phonetic phenomena. Whether ultimately one of these, a combination of them, or none of them turn out to be basic units, the child's acquisition of consonants offers a promising field for crucial experiments, since it seems likely that the basic units of phonology will also be basic units of acquisition or at least closely related to them.

If, for example, distinctive features are basic units of acquisition, some such feature as [$\pm$ continuant] would be acquired at some time in the child's development and might be expected to be added pretty much across the board to various segments of different places of articulation. Present evidence on English fricatives (Moskowitz 1970 and references) suggests that this is not the case, but rather that the phonemes are acquired one by one with considerable time lag between them. If this is so and the assumption is made that distinctive features are the units being acquired, then either the set of fricatives does not share such a feature or there are complications deriving from different clusterings of features or from other factors. Accordingly, study of the acquisition of English fricatives will yield important evidence on this issue, e.g., whether the voicing contrast in fricatives is acquired in the same order as the fricatives themselves are acquired or whether the ranges of phonetic approximations to the different fricatives are similar in nature and stages of development.

(b) Universal Hierarchy

A number of linguists assume the existence of a universal hierarchy of phonetic features which is reflected in the distribution of phoneme types among the languages of the world and in the order in which children acquire the sounds of their first language. The descriptions of the hierarchy and its relation to child language development are not always clear and precise enough to be tested, but the collection of empirical data on order of acquisition provides evidence toward confirmation or disconfirmation of the whole notion as well as specific parts of the hierarchy. There is fairly strong evidence (Shvachkin 1948, Garnica 1970, and the forthcoming Stanford project report) that there is a "normal" order of acquisition of initial consonant discrimination in English or Russian which is of the Guttman scale sort, i.e., the acquisition of opposition Y presupposes the acquisition of opposition X.

The whole question of the order of acquisition is far from being fully decided, however, and additional study is needed for other parts of the phonology and in order to determine the extent of individual variation reflecting different learning strategies, environmental differences, and other factors. It is also essential that this kind of study should be extended to other languages in order to understand the effect of different structures on the order of acquisition and to reach conclusions of general validity. Detailed study of the development of English fricatives and liquids and Spanish intervocalic consonants will provide decisive evidence on this issue, going considerably beyond the Shvachkin and Garnica data.

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(c) Recognition and Production

Most linguistic theorists have tended to take the position that a single phonological system or "competence" underlies both recognition and production of speech sounds by users of a language. It is not clear whether this position is empirically verifiable, but in any case the problem of the relation between recognition and production exists, since the two kinds of behavior do not correspond directly in detail. For example, acoustic invariance does not neatly match articulatory invariance, and mistakes in recognition do not necessarily match mistakes in production. It is even possible that the basic units differ for different kinds of language behavior and are integrated in the central nervous system but not reducible to a single unified system. Clearly, exploration of the relation between recognition and production seems essential to any full understanding of the workings of phonological systems.

Child language development has one phenomenon particularly suited for the study of this relation, namely the so-called "fis phenomenon" (Berko and Brown 1960) in which a child demonstrates that he is able to discriminate between two sounds and correctly assigns them to appropriate lexical items of the language he is acquiring, but seems unable to produce the difference consistently. A classic example of this is Anthony Weir at the stage when his equivalent of adult /θ/ varied among [θ], [f], and [t]; his correct assigning of /θ/ to lexical items was shown by the fact that words with adult /f/ or /t/ did not show the kind of variation that /θ/ words showed (Weir 1962, cited in Moskowitz 1970; for the same phenomenon in adult style variation, cf. Labov 1968. The acquisition of liquids and semivowels in English also illustrates the phenomenon; discrimination among /w r l y/

normally seems to precede correct production by a relatively long period (Menyuk and Anderson 1969). Systematically collected data on this phenomenon are of value not only for elucidating the processes of child language development, but also for the whole question of the validity of "underlying" phonological entities whose surface manifestations are indirect or unclear.

Purpose and Principles

The primary purpose of this project is the collection of a body of empirical data on consonant development in children which is relevant to major issues of phonological theory. No attempt is made to test a whole theory in detail, but in some instances limited hypotheses can be tested, and specific hypotheses are proposed when it seems appropriate to do so. These hypotheses are not drawn from a single comprehensive theory of child phonology development, but are based on parts of one theory and a number of additional principles.

Often it is not desirable to propose an explicit hypothesis, since existing theories do not yield a clear prediction, and principles which might be operative seem in conflict. In such cases the problem is investigated, but no outcome is predicted. For example, it is likely that there is a regular pattern of acquisition of the ability to discriminate among Spanish intervocalic voiceless stops, voiced fricatives, and voiceless fricatives, but apparently no current theory would give a clear prediction of the order of acquisition. Here the evidence will be suggestive for theory makers rather than a confirmation or modification of existing theory.

The bases for the hypotheses tested in the project and for the problems investigated in it without clearcut hypotheses are the Jakobsonian theory as

presented in Jakobson 1968 and Jakobson and Halle 1956, and six additional principles which may overlap or even conflict with the theory. Jakobson's is the most explicit theory of child phonology development and it makes precise probabilistic predictions on the order of acquisition of phonemes-features-oppositions. Parts of it are, however, difficult to interpret: some consonantal phenomena such as semivowels and clusters are omitted, and no provision is made for order within a class such as fricatives or for the acquisition of positional or stylistic variants. Also, discrimination is either ignored or assumed to be attained in the same order as production.

The additional principles, which are derived from a variety of sources, are:

(1) Other things being equal, the less marked phoneme of a class of phonemes will be acquired before the more marked one. Example: In Russian plain /m/ tends to be acquired before palatalized /m'/.

> The term "marked" requires some comment here. The concept of markedness originated with the Prague school of linguistics and has been elaborated by a number of linguists, particularly Greenberg (1966) and Chomsky and Halle (1968). Originally it referred to the presence of a phonetic feature which distinguished one member of an opposition from the other. For example an oral and nasal vowel of the same quality are unmarked and marked respectively since the nasal vowel has the characteristics of the oral vowel plus nasality.
>
> In any given language a phoneme unmarked in this sense tends to be more frequent in occurrence and to have fewer limitations on its distribution than its marked counterpart, and the properties

of frequency and freedom of distribution accordingly came to be used as indicators of unmarked status in instances where the distinction was not simple absence vs. presence of a phonetic feature. Also, unmarked phoneme-types (e.g., oral vowels as opposed to nasal vowels cf. Ferguson 1966) tend to be more widespread among the languages of the world, and this property was added to the notion of markedness. Additional properties which have been attributed to unmarked phonemes include greater range of phonetic variation, better integration into the sound system (i.e., sharing of more features), earlier acquisition in child language development, and later loss in aphasia.

Recently the notion of unmarked or less marked has been extended to designate phonemes which are in some sense simpler or more "natural" than their marked counterparts, even if the phonetic relationship is the reverse of the original concept of marking. For example, by the original phonetic sense, a voiceless /t/ is unmarked with reference to a voiced /d/, but by the extended sense a voiceless l is marked with reference to a voiced l since vowels and sonorants are typically or "naturally" voiced.

The various properties associated with markedness do not necessarily coincide in every instance and the terms "marked" and "unmarked" are therefore equivocal. Here the terms will be used in the basic phonetic meaning, and the other properties will be mentioned separately when applicable.

(2) Labial consonants will be acquired early, primarily because their articulation is visible and lip skills are used in infancy (Jakobson 1960).

Example: In English /m/ tends to be acquired before /n/, although /m/ is more marked and less frequent in occurrence.

(3) Voice oppositions will be acquired late, presumably because voicing is a matter of delicate coordination in timing the action of the vocal cords with the articulation of consonantal segments (Lisker 1951). Once acquired the feature of a voice seems particularly resistant to loss or misperception (Miller and Nicely 1955). Example: In English the s-z opposition tends to be acquired later than m-n.

(4) Non-nasal sonorants, i.e., liquids and semivowels, will be interchanged in production, presumably because of their similarity in vocalic quality; patterns of interchange will vary depending on the language (Menyuk and Anderson 1969). Example: In English, one pattern of substitution is j for initial l-, w for both initial r- and final -l, and ∅ for final -r.

(5) Substitution for adult model phonemes will be systematic, and the substitute typically will be a phonetically similar sound acquired earlier than the model, or it will be in accordance with patterns of assimilation (including reduplication). Example: In English, /b/ is a frequent substitute for initial v- before the /v/ is fully acquired (Moskowitz 1970).

(6) Discrimination of an opposition is acquired before production, and substitution takes place during the period between the two. Example: In English, after the ability to discriminate f-θ and t-θ is demonstrated, the child may continue to substitute /f/ or /t/ for /θ/ (Weir 1962).

Methods of Investigation

(a) Shvachkin-Garnica discrimination techniques

In 1948 Shvachkin, a Russian psychologist, published the results of an experiment on the development of discrimination of phonemic differences in Russian. With a few modifications in method this experiment is being replicated with English-speaking children in an ongoing study at Stanford University (NSF grant GS 2329). The current Stanford study was preceded by a pilot study which showed that, in general, "the experimental paradigm provided by Shvachkin's work . . . can be used fruitfully to investigate phonological development in other languages" (Garnica 1970).

The Shvachkin report only vaguely describes the methods used in the experiment, and the Stanford pilot study worked out a full set of techniques. The report (Garnica 1970) includes an explicit, detailed description of the techniques, procedures and controls, which facilitates further replications of the discrimination experiment.

The method uses a discrimination learning procedure in which objects are given nonsense names which differ only in a single consonant. In the English and Russian studies the names were monosyllables of the form CVC with different initial consonants, e.g., mik-bik. The task procedure is as follows: "To indicate that he can discriminate between the names, the child must perform an action with the object named by the CVC when requested by the experimenter on a given trial. The subject must learn that (a) there is a different name associated with each object presented, and (b) when the experimenter requests one of the objects, he must choose only the object associated with that name if he is to receive a reward. If the subject cannot discriminate between the two initial sounds it is assumed that he

will choose randomly one or the other object, and that over a number of trials the number of correct and incorrect choices will be equal." (Garnica 1970). It must be noted that this technique does not test pure discrimination in the sense that the subject would distinguish directly between two stimuli, but invokes recognition of a sound sequence systematically associated with a particular meaning.

(b) Observation of spontaneous production

For the study of phonological development one of the best methods is still the kind of careful biographical study which consists of a great deal of time spent observing one or more children in natural settings and recording, transcribing, and annotating their speech production. The Stanford project makes use of published biographical studies of child language development (see Bibliography 1970) and they will again be examined for developmental details on fricatives and liquids. A second source, not previously used by the Stanford project, are unpublished bodies of recorded and/or transcribed material. Several of these are of such quality and extent that they can provide a rich source of data on the problems and hypotheses of the project. In particular we hope to make full use of at least one of the following: Olmsted, Bullowa, Ervin-Miller, Brown, in addition to the tapes of the Child Language Data Archive here at Stanford.

Finally, longitudinal production studies on the model of the one in the current Stanford project will be carried out. In these studies recordings of a number of children are made at regular intervals, usually in the home, with the aid of the mother while the investigator and observer take notes.

(c) Word imitation

By simple observation of children's natural speech it is very difficult to get an adequate picture of the children's phonological competence at any

one time. One of the principal reasons for this is the accidental nature of the vocabulary a particular child has. For example, there is no infallible way of finding from ordinary conversation whether the child has any words with /v/ in them. Guided elicitation and parents' records of the child's vocabulary are of help, but a technique is needed to check the limits of the child's competence at a given point in time. We have decided to use simple word imitation.

Word imitation has the minor drawback that it is sometimes difficult to get the child to "play the game" when and for the length of time it is needed. It has the more serious drawback that the child's ability at immediate imitation of words presented to him may differ significantly from his ability to produce words in free speech. The testing of word imitation, however, makes it possible to have the same set of words tried on all children, and the use of nonsense words keeps to a minimum the production differences based on familiarity with a particular word rather than general phonological competence. The child's ability to imitate sound distinctions, although not identical with his ability to produce them in free speech, is probably fairly closely related to it and is even worth study on its own merits as a component of a more general kind of phonological competence.

(d) Subjects

The children who will serve as subjects in this project will be selected largely on the basis of the following criteria:

(1) availability for duration of study

(2) not first born in family

(3) of single birth, not a twin

(4) parents and siblings without speech defects.

The English-speaking children will be recruited chiefly from siblings of pupils at the Bing Nursery School on the Stanford campus, as have been the subjects of the current Stanford child phonology project, and will be limited to those whose parents and siblings are native speakers of Standard American English, with no foreign language spoken in the home.

The Spanish-speaking children will be recruited from the Mexican-American community in Redwood City, starting with families represented in the bilingual education projects there. The effort will be made, however, to recruit largely children from monolingual or near-monolingual homes, so that preference will be given to children who do not have older English-speaking siblings.

The age range of the subjects will vary depending on the particular study, but all of them will be between 1 year and 4 years of age. Further details on subjects are given under the descriptions of the various studies.

Workshops in Child Phonetics

One of the principal problems of child language research has been that of assuring the validity and reliability of the transcriptions of child speech made by different research workers. It is widely recognized that child speech is unlike adult speech in many of its phonetic aspects, but nowhere in the literature is there any extensive systematic treatment of the difficulties in transcribing child speech (for inter-transcriber reliability studies cf. Winitz and Lawrence 1961 and Ma and Herasimchuk 1968). Since the present project requires accurate transcriptions, two training workshops in the general field of child phonetics will be held as part of the project.

Participation in the workshops in child phonetics will be limited to project staff who are directly concerned with recording and transcription of child speech. One workshop will be held in fall 1971, the other in summer or fall 1972, the second one paying special attention to the child phonetics of Spanish. The workshops will be organized to meet the goals listed below, and they will utilize tapes generated by the project as well as other samples of child and adult speech.

The goals of the workshop will be as follows:

(1) To elucidate some of the problems involved in transcribing child speech, particularly in consideration of the differences between children's and adults' production and perception of speech.

(2) To explore alternatives for resolving transcription problems, such as: a) alternative methods of recording and playback, b) the establishing of levels of agreement among transcribers for ambiguous samples, c) the determination of limits of variability in subjects' criterion performance levels, and d) visual display of acoustic signals.

(3) To establish a set of systematic adaptations of the International Phonetic Alphabet for transcribers of child speech.

(4) To determine optimal levels of transcription specificity ("narrowness") for the various studies of the project.

(5) To specify and correct for transcriber biases, both linguistic and idiosyncratic.

(6) To collect materials for a Manual of Child Phonetics for use by the project staff, eventually also by others who transcribe child speech.

On the basis of experience with the project workshops it is hoped that a regular course and textbook (the Manual) on child phonetics can be developed.

The course would be added to the Stanford linguistics curriculum and might be offered in the summer for the benefit of workers in child phonology from other universities and research institutions.

Fricative Studies - Acquisition of English Fricatives

English has a set of eight fricatives, paired voiceless-voiced in four places of articulation:

	labiodental	(inter)dental	alveolar	palatal
voiceless	f	θ	s	ʃ
voiced	v	ð	z	ʒ

These phonemes are characterized in articulation by a constriction of the air passage which produces strong friction and in acoustic effect by the presence of noise or "hiss" between roughly 1500 and 8000 cps. The fricatives are differentiated from one another in articulation by different places of constriction and in acoustic effect by having the hiss at different frequencies, by having different overall intensity, and by the nature of formant shifts in neighboring vowels (Harris 1958, Strevens 1960).

The voiceless-voiced distinction among the fricatives is basically characterized by the addition, during at least part of the segment, of vocal cord vibration and its acoustic counterpart of a periodic low-frequency component. Also, the voiceless series is fortis, often described as articulated with greater force and having a greater overall intensity and duration than the voiced series. In some positions (e.g., final) or special registers (e.g., whisper) this intensity is more important for perception than the voicing. In the basic phonetic sense, however, the voiced series may be

regarded as marked in relation to the voiceless.

The unmarked voiceless series would be expected to have much higher frequency of occurrence in running text but this is only partly the case. The total frequencies are roughly equal, although /sʃ/ are much more frequent than /zʒ/. One important reason for the overall discrepancy is the high frequency of initial /ð/ in demonstrative words the, this, those, there, etc. (Wang and Crawford 1960).

The fricatives are, in general, fairly freely distributed, occurring initially, finally, intervocalically, and in clusters. The special cases are three: the /s/ is distributed more widely than the others (additional clusters) and is by far the most frequent; it is the fricative par excellence, the least marked of all the fricatives (Chomsky and Halle 1968). The /ð/ does not occur in clusters except for certain clusters at morpheme boundaries. The /ʒ/ occurs almost exclusively in intervocalic position and is far less frequent than the others, being in fact the least frequent English consonant.

The /s/ has a wide range of phonetic variation individually and stylistically. Misarticulation of /s/ is one of the commonest "speech defects" of English, whether toward /θ/ ("lisping") or toward /ʃ/, and the latter is often used to represent the /s/ of drunken or drowsy speech.

The three non-palatal pairs participate in morphological patterns in which the addition of voicing contributes a derivational morpheme (a belief: to believe) or produces a stem alternant before a suffix (leaf : leaves). The palatal pair participates in a morphophonemic pattern in which /k/, /t/, and /s/ are palatalized to /ʃ/ under certain conditions (vice : vicious) and /d/ and /z/ to /ʒ/ (divide : division).

All the fricatives except the interdental pair have corresponding stop or affricate pairs (p:b = f:v, t:d = s:z, tʃ:dʒ=ʃ:ʒ) at the same place of articulation: the nearest pair for the interdentals is t:d, which is, however, closer to the alveolar fricatives. On the other hand, the velar stops /k g/ have no fricative counterparts. In English the velar series is particularly defective in that the velar nasal /ŋ/ is somewhat marginal and in some dialects absent, the voiceless fricative /x/ is clearly present in some dialects and special styles but even then is marginal, and the voiced fricative /ɣ/ is completely absent. Generative phonologists posit velar fricatives at a more abstract level or as transitory elements in derivations, but these have no direct phonetic realization comparable to the other fricatives (Chomsky and Halle 1963).

The hypotheses proposed here are formulated on the basis of Jakobsonian theory and the additional principles listed in the section Purpose and Principles, but the facts given above will all be kept in view as possible factors in the acquisition process. For example, the occurrence of /ɣ/ in high-frequency demonstratives, the wide range of phonetic implementations of /s/ in adult English, or the complex nature of the voicing contrast in fricatives may affect the order of acquisition or the details of phonetic development in ways which are not clearly provided for in the theory and principles.

Fricative Study 1. Developmental sequences of discrimination and production of English fricatives.

The study will test three specific hypotheses on the order of English fricatives; it will last about six months and will be preceded by a one-month

pilot study for perfecting the research design and experimental techniques. The first hypothesis is a general one for all languages possessing fricatives with a voicing opposition (i.e., distinctively different voiceless and voiced fricatives); the other two are specific for English although the principles involved are general.

Subjects

A minimum of 12 children will be tested on each hypothesis, and in order to assure this number 18-20 children will be selected as subjects at the beginning. Additional subjects can be selected later for parts of the investigation if this becomes necessary.

The acceptable age range of the children will be the period of maximum development of fricatives, i.e., about 2;0 to 3;6. Each child will be interviewed to check on his production of fricatives and will be eligible for selection if he has at least two fricative sound-types in his ordinary speech. By the nature of the investigation there is no need to have the children at identical chronological ages or stages of language development in other respects.

Procedure

The hypotheses will be tested by interviews each of which will normally use the Shvachkin-Garnica techniques and a word imitation technique. The children will be interviewed twice a week for sessions of about a half hour, exact time depending on the behavior of the child. The normal expectation will be that the discrimination of one pair will be tested in one session together with a related production test. The first one or two sessions will be training sessions, and interviews will be continued until each part

of each hypothesis has been tested with at least three children. In order to minimize the effects of phonological development of the subject over time, a maximum limit of three weeks will be allowed between a child's first and last session on a single hypothesis. The pairs of consonants to be tested are as follows:

Hypothesis 1.	Hypothesis 2.	Hypothesis 3.
s-z; t-d	θ-ð	s-z
f-v; p-b	x-ɣ	s-ʃ
ʃ-ʒ; tʃ-dʒ	f-v	d-ð
θ-ð; t-d	k-g	f-θ

Hypotheses

(Hyp. 1) Discrimination of a voiceless-voiced pair of fricatives implies discrimination of a voiceless-voiced pair of stops or affricatives at the same place of articulation.

This hypothesis is made on the basis of the assumptions that (a) the stops constitute the unmarked term of the stop-fricative opposition and are acquired first, and (b) the voiceless-voiced opposition is acquired relatively late and would be more easily added to the unmarked stops than to the marked fricatives. This posits three stages of development:

Stage I stops (voice non-distinctive); no fricatives

Stage II voiceless and voiced stops: fricatives (voice non-distinctive)

Stage III voiceless and voiced stops; voiceless and voiced fricatives

The hypothesis is phrased in a cautious, minimum form rather than the stronger, maximum form that all voiceless-voiced stop oppositions would be acquired before any fricative pair; the proposed hypothesis allows for gradual spread of a feature across a set of phonemes and thus overlapping between stages.

(Hyp. 2) A. Discrimination of k-g and f-v prcedes discrimination of x-ɣ, which precedes discrimination of θ-ð.

B. Production of the opposition x-ɣ precedes production of the opposition θ-ð.

This hypothesis is made on the basis of the following assumptions: (a) The phonemes /s/ and /f/ will be acquired early because /s/ is the least marked fricative and the most widespread in the world's languages, and /f/ is a labial and hence likely to be acquired early; (b) the interdental fricatives will be acquired late because they are highly marked, have no stop counterparts, are infrequent in English and relatively rare among the languages of the world; and (c) a voiceless-voiced pair of fricatives is acquired after the corresponding pair of stops (Hyp. 1).

If there is any validity to the notion of universal patterns ("laws") of phonological development, the accidental absence of certain sounds from the inventory of the input language should not interfere with the child's ability to acquire them at the appropriate point in his development. The difficulty English-speaking adults have with producing /x/ and more especially [ɣ] (and also /ŋ/ for speakers who lack it) may well reflect later inhibitory processes similar in nature to the reduced ability of the child to produce souns he made in babbling. Present evidence in general supports the early acquisition of /f s/ and the late acquisition of /θð/ in English (Moskowitz 1970 and references); there is no direct evidence on the "acquisition" of /x ɣ/ in English.

The stages assumed here, omitting the palatal obstruents and combining discrimination and production, are:

Stage I	p-b	--	t-d	k-g
	f-v	--	s-z	--
Stage II	p-b	--	t-d	k-g
	f-v	--	s-z	x-ɣ
Stage III	p-b	--	t-d	k-g
	f-v		s-z	x-ɣ

(Hyp. 3) A. For each of the oppositions s-z, s-ʃ, d-ð, f-θ, discrimination precedes production.

B. For each of the oppositions s-z, s-ʃ, d-ð, f-θ, substitution of the left-hand member for the right-hand member precedes stable production.

This hypothesis is based on the following assumptions: (a) unmarked is acquired before marked: each of the pairs consists of phonetically similar consonants one of which is less marked, better integrated, and more frequent than the other; (b) discrimination precedes production in general; (c) substitutions are systematic and predominantly in the direction of earlier acquired for later acquired.

The basic assumption here is that the child first learns to discriminate between the two consonants and stores lexical items correctly and then he gradually masters the articulatory problems of the more marked phonemes. The hypothesis is stated loosely enough to allow for such possibilities as the substitution of other consonants (e.g., t as well as f for /θ/) or an intermediate stage so short in a given instance that no substitutions are observed. Evidence against the hypothesis would include production without discrimination or preference for reverse substitution (i.e., more marked for less marked). Of interest also would be different results for different pairs.

The stages assumed here, using the s-z pair as illustration are as follows. Left of the arrow is the adult model, right is the child's replica

(for model-and-replica see Ferguson 1968, for the rewrite notation for child substitutions see Compton 1969).

	discrimination	production
Stage I	s, z → s	s, z → s
Stage II	s → s z → z	s, z → s
Stage III	s → s z → z	s → s z → s, z
Stage IV	s → s z → z	s → s z → z

Fricative Study 2. Development of Production of English Fricatives

This will be a longitudinal study of a small number of children, based on periodic observations of their use of fricatives in spontaneous speech and word imitation. No explicit hypotheses are to be tested. The observations will focus on three topics: (1) the development of the phonological subsystem of fricatives, including differences in phonetic implementation in different positions, (2) the phonetic detail of successive approximations to the adult model, and (3) the patterns of substitution of one phoneme for another to the extent that this framework is applicable (Ferguson 1968, Bullowa and Jones 19 , Compton 1969).

Subjects

The subjects at the beginning of the study will be six children at approximately two years of age who regularly produce at least one fricative in their ordinary speech. It is hoped that they can be the same subjects

used for Glide Study 1.

Processing and Data Presentation

The subjects will be observed in their homes at two-week intervals for approximately one full year. The observation sessions will consist in varying amounts of spontaneous speech, guided elicitation, and word imitation, depending on the personality of the child, the situation at the time of observation, and the data requirements of the investigator. All the sessions will be recorded, in the hope that at the conclusion of the study there will be at least ten hours of recorded speech from each of at least four children, taken during the period of maximum development of the fricative subsystem.

In spite of theoretical and practical problems involved in the study of the fricative subsystem without concurrent, full-scale study of the whole phonology or at least of the total consonantism, it is felt that the sharper focus will yield both useful data and new insights on phonological development. The primary method of data presentation will be a succession of phonological grammars of the fricative subsystem, probably on the order of six such grammars over the twelve-month period. This procedure, followed by Grekoff in his unpublished study of Nicholas, eliminates the need for transcribing the total output of the child. The total speech corpus of each will be available on tape, however, along with observers' notes on the sessions, for validation of the grammars and for other research purposes. An additional method of data presentation will be the writing of "rules of change" for successive phonetic stages of (a) selected phonological segments in structurally significant positions, e.g., the successive stages of implementation of adult /v/ in initial position, and (b) selected individual

words, e.g., the successive steps of implementation of shoes, juice, very.

In the transcription and description of the fricatives and related consonant sounds, the degree of phonetic detail will generally be limited to such sound-types or directions of variation as are generally noted for positional, stylistic, or dialectal variation in English, although some sound-types may also be identified which are likely to be noticed by the adult speaker of English as falling between recognized phonemic norms, e.g., a lisped /s/ different from /θ/, or as marking a foreign or personal accent, e.g., a strongly rounded /ʃ/. No attempt will be made to achieve greater specification of phonetic detail in this study, but it is expected that particular phenomena will be selected for subsequent instrumental investigation.

As a complement to this study a number of published diary studies will be examined in detail for the data they may provide on the development of the production of English fricatives.

Glide Studies - Acquisition of English Glide Consonants (r l w j)

The English liquids /r l/ and semivowels /w j/ (henceforth called the glide consonants) are of particular interest to the study of phonological acquisition for several reasons. First, /r/ and /l/ are mastered comparatively late in the developmental sequence and are frequently produced with /w/ and /j/ as substitutions. Some children still make such errors well into the school-age years. (Powers 1957). Second, discrimination among these speech sounds normally seems to precede their correct production by a relatively long period (Menyuk and Anderson 1969). Also, studies on the production of these sounds, especially those concerned with /r/, provide

contradictory evidence on the order of their acquisition as singleton consonants and in consonant clusters.

In the phonological literature no distinctive feature has been posited which would characterize the glide consonants as such; however, they have certain articulatory, distributional, and acoustic properties which justify their study as a set. From an articultory standpoint, they differ from stops and fricatives in the degree of oral stricture, and from the nasals by their oral articulation. With respect to distributional factors, the majority of the allophones of /r l w j/ are voiced oral resonants and the voiceless fricative allophone occurs after voiceless stops or fricatives in the same syllable (Jones 1934). Furthermore, as members of initial consonant clusters the glide consonants must occupy a position in the syllable in immediate contact with the following vowel. They are also the only sounds permitted as the third term of a three-term initial consonant cluster, i.e., #(C)(C)(glide consonant) . . . # (Scholes 1966).

The acoustic properties of the glide consonants have been investigated in initial position by O'Connor et al. (1957) and in intervocalic position by Lisker (1957). O'Connor et al. isolated two acoustic cues which were common to the glide consonants -- "steady-state onset" and transition duration. They found that at the beginning of each formant for /r l w j/ there is a relatively short steady-state representing explicit consonant loci. Further, the formants not only begin at the loci, but continue for 30-50 m-secs before proceeding to the steady-state position of the following vowel. The second formant value is sufficient to distinguish /w/ from /r l/ from /j/,

while the distinction of /r/ from /l/ depends primarily on the third formant transition.

Other acoustic data (Lisker 1957) has shown that the glide consonants in intervocalic position can be synthesized from acoustic patterns consisting of five segments each, where segments numbered 1 and 5 are the steady-states of the preceding and following vowels respectively. The acoustic characteristics of segment 3 mark membership to the glide consonants as a set, while features of segments 2 and 4 differentiate among them.

The glide consonants (r l/ are frequently misarticulated by school-aged children (Powers 1957). For the initial r followed by a vowel the most common substitution is w for r; this substitution and labialized r constitute most of the errors. In the sequence final r preceded by a consonant, in addition to the two errors just noted, omission of the r entirely is common (Curtis and Hardy 1959). The misarticulation of l commonly involves the substitution of w or j.

Glide Study 1. The Acquisition of the Glide Consonants as Singletons and in Clusters.

Problem

The relationship between the order of acquisition of consonants as singletons, i.e., surrounded by boundaries or vowels, and in clusters, i.e., sequences of two or three consonants, seems to be a complex one. In the case of /r l w j/, available diary studies and experimental data provide contradictory evidence on this issue. Since many studies have been directed toward the acquisition of /r/, the available data on this speech sound can serve as an illustration of the problem.

Diary studies (Leopold 1947; Lewis 1951; Velten 1943) of English-speaking

children report that /r/ is produced in a cluster before it appears as a singleton. Also, Curtis and Hardy (1959), studying school-aged children with functional (as opposed to organic) misarticulation, found that /r/ was more often produced correctly in clusters than as a singleton. Murray (1962) observed similar behavior when testing children with "normal" articulation. However, Buck (1948) found to the contrary that /r/ was articulated correctly more often as a singleton than in clusters, and Templin (1957) obtained similar results.

Such contradictory evidence suggests that a systematic study of the relationship between acquisition of glides as singletons or in clusters is warranted. It is probably simplistic to assume that because, in general, clusters are acquired late in the developmental sequence (McCarthy 1959), the glide consonants are first learned as singletons and then combined with other consonants already learned to produce consonant clusters. Since the relationship between singletons and clusters is not well understood in phonological theory, if a relationship can be shown in child language acquisition, then a contribution to the understanding of this issue will have been made.

The purpose of the proposed study is to examine the glide consonants in the various phonetic contexts as they occur in the speech of several children over a period of several years to seek answers to the following questions:

(a) In what phonetic contexts are the glide consonants first produced?

(b) With respect to substitutions for glide consonants

(1) What substitutions occur?

(2) In what phonetic contexts do they occur?

(3) In what developmental sequence, if any, do they occur?

Procedure and Data Analysis

To provide answers to these questions the speech of six children will be recorded over a period of about two years, starting at the point when these children first start to produce words (approximately one year of age). Each child will be visited in his home once a week for a period of several hours per session. The child's mother will be asked to keep a record of the new words that the child has attempted during the week. An effort will be made to elicit these words at the recording sessions. At first these recordings will probably contain almost all the words that the child is producing. As the child's vocabulary increases and it becomes impossible to elicit a complete inventory of words, an attempt will be made to concentrate on recording those words in the child's speech which contain glide consonants in the adult model. Picture books will be used to facilitate the elicitation of words when possible.

Two trained investigators will be present at each recording session. One will take charge of the recording equipment and interact with the child and his mother; the other will make a preliminary phonetic transcription of each of the child's utterances and keep notes on the manner of their production and the tentative English glosses they represent. The two investigators will alternate in filling these two roles. Immediately after the recording session each experimenter will independently transcribe the recorded utterances. The transcriptions will subsequently be compared and an attempt will be made to resolve any discrepancies which may occur.

The transcribed utterances of the children will be analyzed in two ways. First, the phonetic context(s) in which each of the glide consonants first appears will be described for each child. Further, the child's realizations

of each glide consonant in each phonetic context will be noted. Second, the children's utterances will be analyzed for substitutions (Ferguson 1968). A systematic analysis of the substitutions for a given glide consonant (or subgroup of glide consonants) in both singletons and clusters, (b) all children being studied have the same or some limited set of possible substitution patterns, and (c) a developmental sequence of patterns of substitutions can be found.

Glide Study 2. The Developmental Sequence of Discrimination and Production.

Problem

Experimentation with adult subjects, comparing the identification and discrimination of synthetic speech sounds, has led to the hypothesis that the discrimination of these sounds is directly related to the ability to produce them (Liberman et al. 1963). However, some observers have expressed doubt about this hypothesis on the basis of various findings. For example, several experiments with young infants (Moffett 1969) have shown that they can discriminate consonant sounds at a very early age. If this hypothesis is sound, one would suspect that children cannot correctly discriminate oppositions before they can produce them.

The glide consonants /r l w j/ are of particular interest for studying this. Numerous studies report that these speech sounds are some of the latest to be correctly produced (Templin 1957, Wellman 1931, Poole 1934), yet preliminary evidence (Garnica 1970) suggests that they are discriminated well before the age of three years. Furthermore, Menyuk and Anderson (1968), who studied children's identification and production of /w r l/ in initial position, found that children's performance on the production task differed from their performance on the discrimination task. These findings do not

support the hypothesis stated by Liberman et al., at least with respect to children. Instead, the evidence suggests the hypothesis that with respect to a given opposition of speech sounds, phonological discrimination precedes production in the developmental sequence. The present study proposes to test this hypothesis for the glide consonants /r l w j/ with children 1;6 to 4;0 years of age.

Procedure and Data Analysis

The subjects in this experiment will be ten children in each of the following age groups:

Age group I	1;6-2;0 years
Age group II	2;6-3;0 years
Age group III	3;6-4;0 years

These age groups were chosen to maximize differences among the children with respect to the number of oppositions discriminated.

The stimulus items will consist of pairs of nonsense CVCs which differ only in the initial glide consonant. All possible combinations of the glide consonants will be tested. These oppositions are:

l-r	l-j
l-w	r-j
r-w	w-j

Each child will be tested on each of these oppositions for a total of six sessions over a period of two weeks. The order in which the oppositions are tested will be randomly assigned for each child.

The Shvachkin-Garnica technique will provide the data on discrimination of the oppositions. In addition, the child will be taught to repeat the test CVCs after the experimenter produces them, thereby providing the production data. Each test session will be tape-recorded and the child's reproductions phonetically transcribed. It is surmised that the children will readily repeat the test CVCs since prior experimentation with this

technique (Shvachkin 1948; Garnica 1970) has indicated that many of the children "spontaneously" repeat the test items during the test sessions.

A training period will precede the testing of the glide consonant oppositions, the purpose of which will be to accustom the child to the experimenter and to teach him the testing procedure. Stimulus items for the training sessions will consist of nonsense CVC pairs which differ grossly (e.g., bik vs. dup). When a child can make a correct choice on at least 7 out of 10 trials, the test CVCs containing the glide consonants will be presented. This training period may be considerably shorter for the older than for the younger children.

Upon completing data collection each child's performance on the discrimination and production task will be compared for each of the oppositions in question. Analysis of this data will indicate whether discrimination precedes production for all the oppositions tested, or just some subset of these oppositions. In addition, the data should permit a statement on the preliminary ordering of the acquisition of the discrimination and production of these oppositions in word initial position.

Spanish Studies - Acquisition of Spanish Intervocalic Consonants

Spanish was chosen as the language to be investigated for the following three reasons:

(1) The availability of a Spanish-speaking population in the Stanford area. Redwood City has a large Spanish-speaking population and in many homes the children are raised in a monolingual environment, hearing and speaking only Spanish until they are old enough to go to school. Stanford students in linguistics and related fields are now participating in a research program in connection with bilingual education in Redwood City, and this new

research can be related to the existing pattern of community cooperation.

(2) Our interest in studying patterns of language acquisition among minority groups in the Bay Area (Chicanos, Orientals, Blacks). In addition to this investigation of phonological development in Spanish, support has been requested for a study of the acquisition of certain morphological and semantic distinctions among children from Spanish, English, and Cantonese speaking environments. There will be some overlap of personnel in these projects and interaction of the two will be beneficial to both.

(3) Special characteristics of Spanish phonology. The consonant system of Spanish, although in large part like that of Russian and of English, has certain special characteristics of interest: a) voiced fricatives occurring as nondistinctive variants of stops; b) two r phonemes; c) a palatal nasal.

In extending the investigation to another language we are also extending the technique to the study of intervocalic consonants instead of initial consonants. This decision is particularly appropriate for Spanish since many of the sounds to be investigated occur only or chiefly in the intervocalic position, namely, the voiced fricatives, the contrast between r and r̄, and the palatal nasal.

Special Characteristics of Spanish Consonantism

a) The voiced stops in Spanish, b, d, g, are realized as voiced fricatives [β ð ɣ] in certain phonetically conditioned environments and some styles of pronunciation (Harris 1969, 37-45). In casual speech, voiced stops occur in all other positions, for example, [d]os "two" la[ð]os [ ] "sides"; in more careful speech there is a greater incidence of the stop pronunciation. (The voiceless fricatives /f s x/ have voiced allophones in certain phonetically conditional environments and some styles of pronunciation, but this does not include intervocalic position, and apart from [z] for /s/ this phenomenon

is of infrequent occurrence by the nature of the phonetic conditioning.)

b) Spanish, unlike English and Russian, has two "r" phonemes: a voiced apico-alveolar single-flap /r/ and a voiced apical trill /r̄/. The /r/ and /r̄/ contrast only in intervocalic position: pero "but", perro "dog"; in other positions there is a range of phonetic variants determined by the environment (Harris 1969).

c) The three nasals in Spanish, m, n, ɲ, occur distinctively only between vowels: cama "bed", cana "gray hair", caña "cane". Apical /n/ is the least restricted in occurrence; it appears initially, medially as a singleton and in clusters, and finally. Labial /m/ can occur initially and medially, singly or in a cluster, but never appears in final position. Palatal /ɲ/, highly restricted, occurs chiefly in position as a singleton; it does not occur finally and it occurs initially only in highly marginal items such as onomatopoeias (Harris 1969).

d) Like all languages, Spanish has certain restrictions of distribution on consonants. Of the 17 consonant phonemes (see chart below) all except two -- /r/ and /ɲ/ -- can occur word-initially; only five appear in final position: /r n s l d/; however, all 17 occur intervocalically, the position of maximal contrast.

Consonant Phonemes of Spanish

		labial		apical		palatal		velar	
		vl	vd	vl	vd	vl	vd	vl	vd
stop/affricate		p	b	t	d	t		k	g
fricative		f		s			j	x	
sonorants	nasal		m		n				
	liquid: lateral				l				
	liquid: flap				r				
	liquid: trill				f				

Spanish Study 1. Development of Discrimination of Spanish Intervocalic Consonants.

Proposed Investigation

The investigation will last 8 to 9 months and will be preceded by a 3-month pilot study which will allow us: a) to obtain a preliminary ordering of acquisition of perception of Spanish consonants, both initial and intervocalic; b) to adapt the Shvachkin-Garnica technique for application to Spanish; c) to familiarize the investigators with the techniques. The main study will test four hypotheses, two about the order of acquisition of consonant discrimination in terms of general classes, and two on the within-class order of acquisition of nasals and liquids. Finally, it will investigate the problem of the discrimination of stops and fricatives.

Subjects and Investigators

The children selected for this study will come from monolingual or nearly monolingual Spanish-speaking environments, and will be between 1;5 and 1;10 at the beginning of the study. Since the children will come from Mexican-American homes, those investigators who work directly with the subjects will be Mexican-Americans, so that cultural and linguistic intrusion will be minimal.

Procedure

Testing sessions will be conducted twice a week over a period of 8-9 months. The children are tested individually in the presence of two investigators; one works directly with the child, the other observes, recording the subject's responses and keeping notes on the activities of the session.

Results from the testing sessions will be analyzed statistically, using the same system of analysis as was used in the study with English-speaking children.

The stimuli to be used in the proposed study will differ somewhat from those used in the English and Russian experiments. Since we are interested in the development of intervocalic, rather than initial consonants, the nonsense names we use will be disyllables of the form VCV. Each pair of names presented to the child, then, will differ only in the consonant; sample pairs might be [ono]-[omo] or [apa]-[afa]. The items will be designed so that none of them is a real word that the children may already know.

With 17 consonant phonemes in Spanish (see chart on preceding page), there are 136 possible stimulus pairs. Of these, we will focus on the 25 oppositions which are of particular interest because they involve phonemes and contrasts not found in English and/or Russian. The pairs of consonants we plan to test consist of the following:

(1) nasal-liquid-stop	m-l, m-k, k-l
(2) nasals	m-n, m-ɲ, n-ɲ
(3) liquids	l-r, l-r̄, r-r̄
(4) stop-fricatives	p-β, p-f, β-f
	t-ð, t-s, ð-s
	k- , k-x, ɣ-x
	tʃ-s
(5) fricatives	f-s, f-j, f-x, s-j, s-x, j-x

Hypotheses and Problem

Nasal-liquid-stop m-l-k

(Hyp. 1) Of the sets of oppositions to be tested, the oppositions m-l-k will be acquired before all the others.

This hypothesis is based on the assumption that /m l k/ are maximally differentiated among Spanish consonants, in that they differ maximally in place of articulation: /m/ is bilabial, /l/ is apical, /k/ is velar; and in manner of articulation: /m/ is a (voiced) nasal, /l/ is a (voiced) liquid, and /k/ is a voiceless stop.

(Hyp. 2) Among the three consonants /m l k/, the opposition between /k/ and the other two will be acquired first, then the opposition m-l.

The /m/ and /l/ belong to the same class, sonorants, and thus share more features than either one does with /k/.

Nasals m-n-ɲ

(Hyp. 3) Among the nasal oppositions, that between labial /m/ and non-labial /n/ or /ɲ/ will be acquired before the opposition between apical /n/ and palatal /ɲ/.

This hypothesis is based on the following: among the world's languages n is nearly universal and m is by far the commonest second nasal (Ferguson 1966). In child language acquisition m as a labial is acquired very early, typically before n (Jakobson 1960).

Liquids l-r-r̄

(Hyp. 4) Among the liquids, the oppositions between l and the two r's will be acquired before the opposition between /r/ and /r̄/.

Acoustico-articulatory data indicate that the two vibrant liquids, [r] and [r̄] vary considerably in phonetic features. Harris 1969 cites 7 different phonetic realizations of r in non-intervocalic position. The laterial [l], on the other hand, is far more stable phonetically; l is alveolar when word-initial, between vowels, and word-final, and before labial, labio-dental, alveolar, and velar obstruents. It assimilates to the point of articulation

of a following dental /t d/ or alveopalatal /tʃ/ obstruent within a word in slow, "careful" speech; the same assimilation occurs across word boundaries as well as within a word in faster, "casual" speech. The relative phonetic stability of /l/ as compared with /r/ or /r̄/ is one factor on which the hypothesis is based.

A second factor is the restrictions of distribution of the three liquids. The lateral /s/ has the fewest limiations, as it can appear initially, medially, and finally. The trill /r̄/ occurs initially and medially, while the flap /r/ occurs medially and finally. The two contrast phonemically only in intervocalic position. Thus it seems likely that the child will learn the distinction between the two vibrants late in his development of perception.

Finally, /r/ and /r̄/ share more features with each other than either one shares with /l/.

Stops-fricatives p-β-f, t-ð-s, k-ɣ-x,tʃ-s

Predicting the order of acquisition of the stop/fricative oppositions (e.g., p-β, β-f, p-f) involves consideration of a factor not previously investigated in studies of phonological development: the acquisition of a phonetic variant, i.e., an allophone. Whereas the phonetic features of the voiceless stops and fricatives are relatively stable regardless of position within a word, the voiced consonants /b d g/ have two main variants: they are stops [b d g] in word-initial position and after certain sonants and they are continuants [β ð ɣ] between vowels and elsewhere.

It seems likely that the first opposition acquired will be between the "stable" voiceless pairs p-f, t-s, k-x. The question then is, will the

voiced fricatives at that stage be identified with the voiceless stops or with the voiceless fricatives?

Taking the set of labial consonants as an example, a simple feature analysis of [p β f] reveals that [β] shares more features with [f] than with [p]:

p	β	f
-cont	+cont	+cont
-voice	+voice	-voice

On the basis of features alone, then, one would predict that a child is more likely to identify [β] with [f] than with [p].

Sounds cannot be viewed as unique segments, however, but as part of a system. Within the Spanish consonant system, [β] is one phonetic realization of /b/; the other main variant is [b]. In certain speech styles the differences between [b] and [β] tend to disappear. In casual or "allegro" speech, for example, word-initial voiced stops become continuants after a vinal vowel of the preceding word, e.g., la [β]oca "the mouth" instead of la [b]oca; conversely, in very careful or clarifying speech, voiced intervocalic continuants are sometimes realized as stops, e.g., na[b]os "turnips" instead of na[β]os in an angry correction. Confusion between voiced stops and fricatives during the period of acquisition seems inevitable, then, and although it cannot be tested directly in a discrimination study such as this, evidence of this confusion should appear in the proposed study of consonant acquisition. Thus, if a child identifies [b] with [β], he will be more likely to confuse [β] with [p] than with [f], since the opposition between stops and fricatives is generally acquired before the voicing opposition.

Spanish Study 2. Development of Production of Spanish Intervocalic Consonants

Proposed investigation

The second part of the proposed investigation is a study of the development of production of consonants by Spanish-speaking children. As in the discrimination study, we will be primarily interested in the order of acquisition of consonants in intervocalic position. Besides serving as a testing ground for various theories of phonological acquisition, the data gathered here can be compared with those gathered in previous studies of language development of English-speaking children and with diary studies of children's acquisition of various other languages.

Of particular interest in this study is the acquisition of sounds or classes of sounds mentioned in the section "Special characteristics of Spanish phonology": the voiced fricatives, the two "r" phonemes, the three nasals and others. In general, development of the production of Spanish consonants is expected to follow the pattern predicted by Jakobson 1968. His theory, however, makes no mention of the acquisition of allophonic variants, nor does it predict order of acquisition within consonant classes.

Three specific hypotheses will be tested on the order of acquisition of nasals and liquids, and the order of fricatives and stops will be investigated with reference to a predicted pattern of acquisition.

Subjects

The subjects will be Mexican-American children from Spanish-speaking homes in Redwood City. In order to collect data on the acquisition of all the consonants, subjects will be selected from two age groups: a) a younger group comprised of six children who are barely past the "first word" stage:

these subjects, probably 13-17 months old, will have a small (3-5 words) vocabulary and a limited phonological system at the beginning of the study; b) an older group comprised of six children 21-25 months old; they will have a more developed, but not complete, phonological system and will be producing short (2-3 words) sentences.

An important criterion in selecting subjects is the linguistic environment in which the child is being raised. To insure that this environment is essentially monolingual, none of the children in this study will have older siblings of school-age. Subjects will be tested at weekly intervals over a period of six months.

Procedure

Each subject will be visited in his home by two experimenters, one of whom works directly with the S, the other observes, transcribing all utterances produced by the S during the session. Each session, one-half hour long, will be taped and later transcribed by both Es independently. The E who works with the Ss will be a native speaker of Mexican-American Spanish. The basic technique will be word imitation. The E who works with the child will ask him to play the game "Can you say _____?" or "Say what I say: _____." The words the child is asked to imitate are (C)VCV nonsense forms, chosen so that all 17 consonant phonemes are tested in intervocalic position, and all except /r/ and /ɲ/ also in initial position.

Hypotheses and Problem:

Nasals m-n-ɲ

(Hyp. 5) The production of labial m will be acquired earliest of the three nasals, followed closely by dental n, and then, after some time, by palatal ɲ.

Stops/fricatives

The predicted development of stops and fricatives is as follows:

Model	apa	a a	afa
Stage I	aPa	aPa	aPa
Stage II	aPa	aPa	aPa
Stage IIIa	apa	aβa	afa
Stage IIIb	apa	a a	afa

P = labial stop, voicing non-distinctive

F = labial fricative, voicing non-distinctive

At the earliest stage, when the child can produce a stop but not a fricative, voicing is non-distinctive, hence the cover symbol P. In Stage II the feature [+ continuant] has been added, appearing in the imitation of afa but not of aβa. In Stage IIIa, the voicing feature is acquired, distinguishing apa from aba. At this stage the child has a three-way phonemic distinction: p:b:f, but not the allophonic variation present in the voiced stops. Finally, in stage IIIb, intervocalic 'b' is realized as [β], as in the adult model.

The crucial stage in this prediction is the second one. If the feature [+ continuant] is added in one form, why doesn't it appear in the other? The following factors were considered in making this prediction: a) p and f are independent phonemes, is not; b) the initial contrasts p-:b-:f- are parallel to the intervocalic contrasts p-:β-:f-; c) β→b in careful speech, b→β in casual speech.

Liquids

(Hyp. 6) The liquids l, r, r̄ will be the last class of sounds to be acquired. Previous observations of the acquisition of various languages (English, French, Russian, Italian, among others) indicate that "correct" (i.e., adult) production of the liquids generally occurs late in the development of the phonological system. In English, for instance, it is not uncommon for a 3- or 4-year-old to substitute w for initial r, saying wabbit instead of rabbit.

(Hyp. 7) The lateral /l/ will be acquired before the flap /r/ or trill /r̄/. This hypothesis is based on several factors: l has fewer limitations on distribution than /r/ and /r̄/; l has fewer phonetic variants; /r/ and /r̄/ share more features with each other than either does with l; l contrasts with /r/ and/or /r̄/ in initial, medial, and final positions, whereas /r/ and /r̄/ contrast only between vowels.

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